Terra SSF Simple Surface Flux Parameterizations

David P. Kratz
Atmospheric Sciences, NASA Langley Research Center
Hampton, Virginia

Anne C. Wilber & Shashi K. Gupta
Analytical Services and Materials, Inc.
Hampton, Virginia

1st CERES-II Science Team Meeting
Boulder, Colorado
March 29, 2004

Validation of Terra/SSF Surface-only Fluxes

- Down-welling clear-sky and all-sky SW and LW surface fluxes derived from relationships with TOA fluxes and atmospheric data.
- Each component currently computed from two models

  LPSA/LPLA:
  Langley Parameterized SW/LW Algorithm

		Model A	Model B
SW	Clear	Li et al.	LPSA
	All-sky	-	LPSA
LW	Clear	Inamdar and Ramanathan	LPLA
	All-sky	-	LPLA

- Validation criteria:
  ±20 Wm^{-2} for instantaneous CERES FOV
- Validation data sources: SURFRAD, ARM/SGP, BSRN, & CMDL
- FM1 and FM2 results almost identical; only FM1 results shown

Algorithms/References

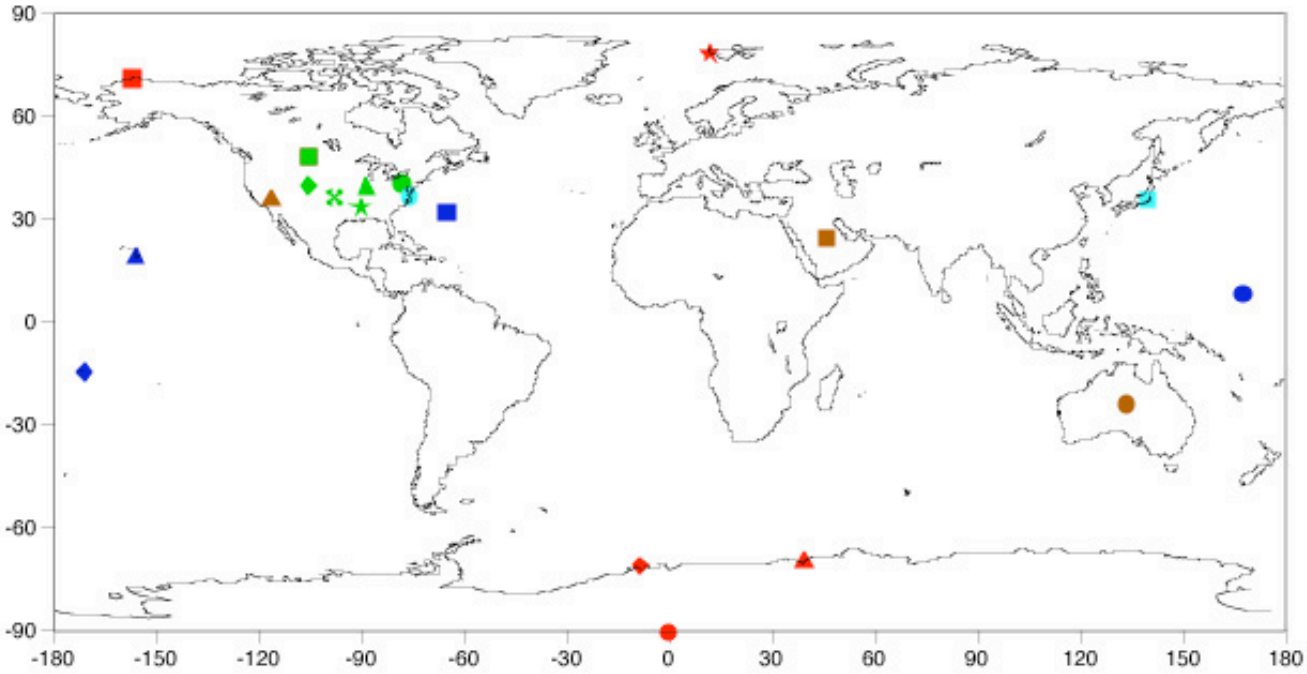
- SW Model A:
  Li *et al.* (1993): *J. Climate*, **6**, 1764-1772.

- SW Model B (LPSA/Staylor Algorithm):
  Darnell *et al.* (1988): *J. Climate*, **1**, 820-835.
  Darnell *et al.* (1992): *J. Geophys. Res.*, **97**, 15741-15760.
  Gupta *et al.* (2001): *NASA/TP-2001-211272*, 31 pp.

- LW Model A:
  Inamdar and Ramanathan (1997): *Tellus*, **49B**, 216-230.

- LW Model B (LPLA):
  Gupta (1989): *J. Climate*, **2**, 305-320.
  Gupta *et al.* (1992): *J. Appl. Meteor.*, **31**, 1361-1367.

- SW & LW Model B Validation
  Gupta *et al.* (2004): *Accepted to J. Atmos. Ocean Tech.*



- 48.31N, 105.10W Fort Peck, MT
- 40.72N, 77.93W Penn State, PA
- 40.05N, 88.37W Bondville, IL
- 40.13N, 105.24W Boulder, CO
- 34.25N, 89.87W Goodwin Creek, MS
- 36.60N, 97.48W SGP ARM
- 32.30N, 64.77W Bermuda
- 8.72N, 167.72E Kwajalein
- 19.54N, 155.58W Mauna Loa, HI
- 14.23S, 170.56W American Samoa
- 36.05N, 140.13E Tatano
- 36.9N, 75.71W COVE
- 71.32N, 156.61W Barrow, AK
- 90.00S, 0.00 South Pole
- 69.00S, 39.58E Syowa
- 70.65S, 8.25W Georg von Neumayer
- 78.9N, 11.95E Ny Alesund
- 24.91N, 46.41E Saudi Solar Village
- 23.70S, 133.87E Alice Springs
- 36.63N, 116.02W Desert Rock, NV

Available Data Periods

Terra Edition-2A SSF - 25 Months (March 2000 - March 2002)

All ARM, CMDL, and SURFRAD Data Cover the Entire Period

Some BSRN and Other Sites Cover Shorter Periods:

- Tateno, Alice Springs, Georg von Neumeyer, Ny Alesund, Syowa Cover 13 Months (March 2000 - March 2001)
- Saudi Solar Village (NREL) - Data Missing for Dec. 2001
- Chesapeake Lighthouse (LaRC) - Data Available Sept. 2000 through March 2002

Surface Site Summary

Quality Control, Timeliness, & Documentation

SURFRAD: Extensive QC done prior to release, Released daily, Well-documented.

ARM: QC relies upon user comments, Staged weekly, Well-documented.

CMDL: Extensive QC done prior to release, Quickly made available after review, Well-documented.

BSRN: Files contain QC flags, Released 1 month to several years later, Uneven documentation (some surface sites don't have web sites).

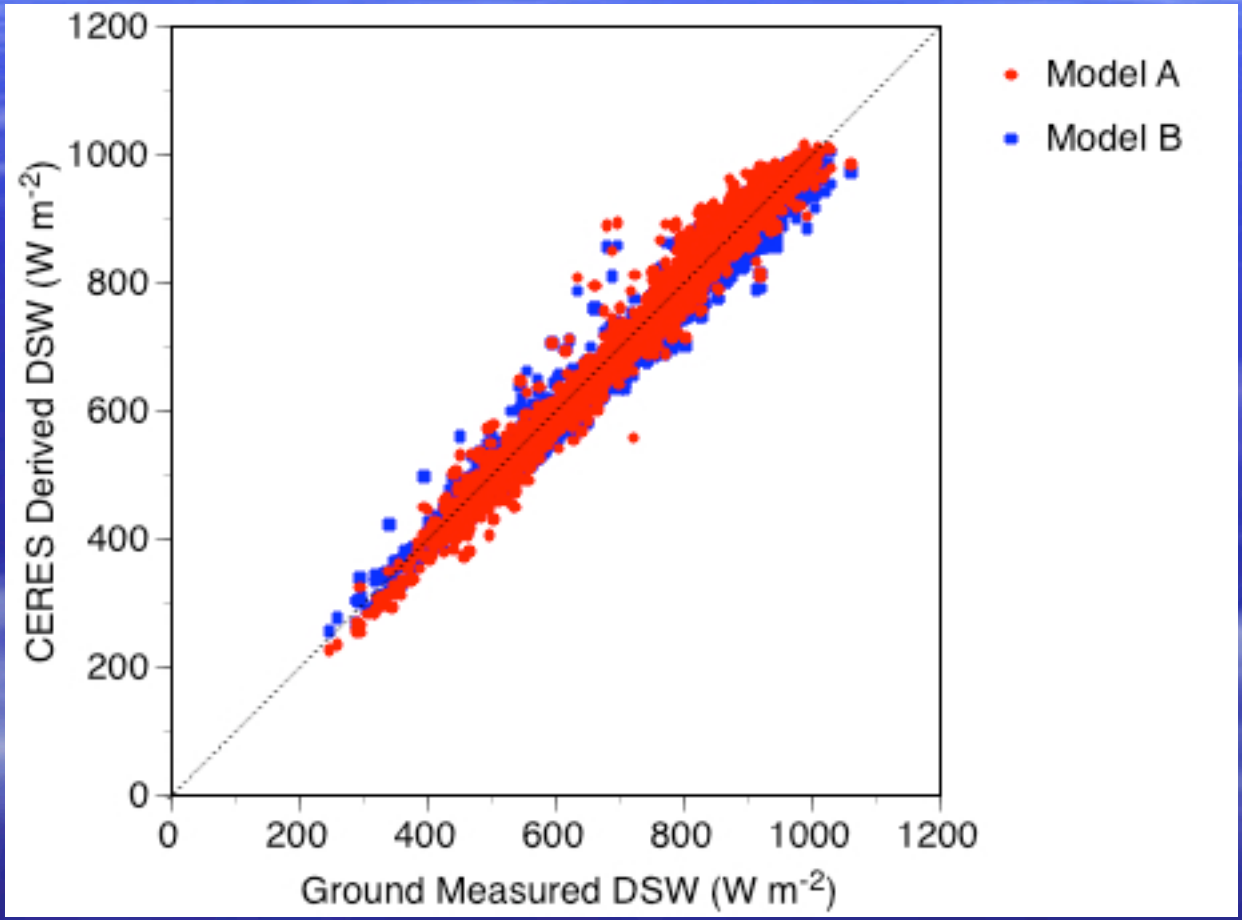
Direct + Diffuse versus Unshaded Pyranometer Measurements

Direct + Diffuse [Normal incidence pyrheliometer (NIP) + Shaded pyranometer] measurements are used when they are available and when quality control shows that the data are free from known problems (e.g., tracker errors).

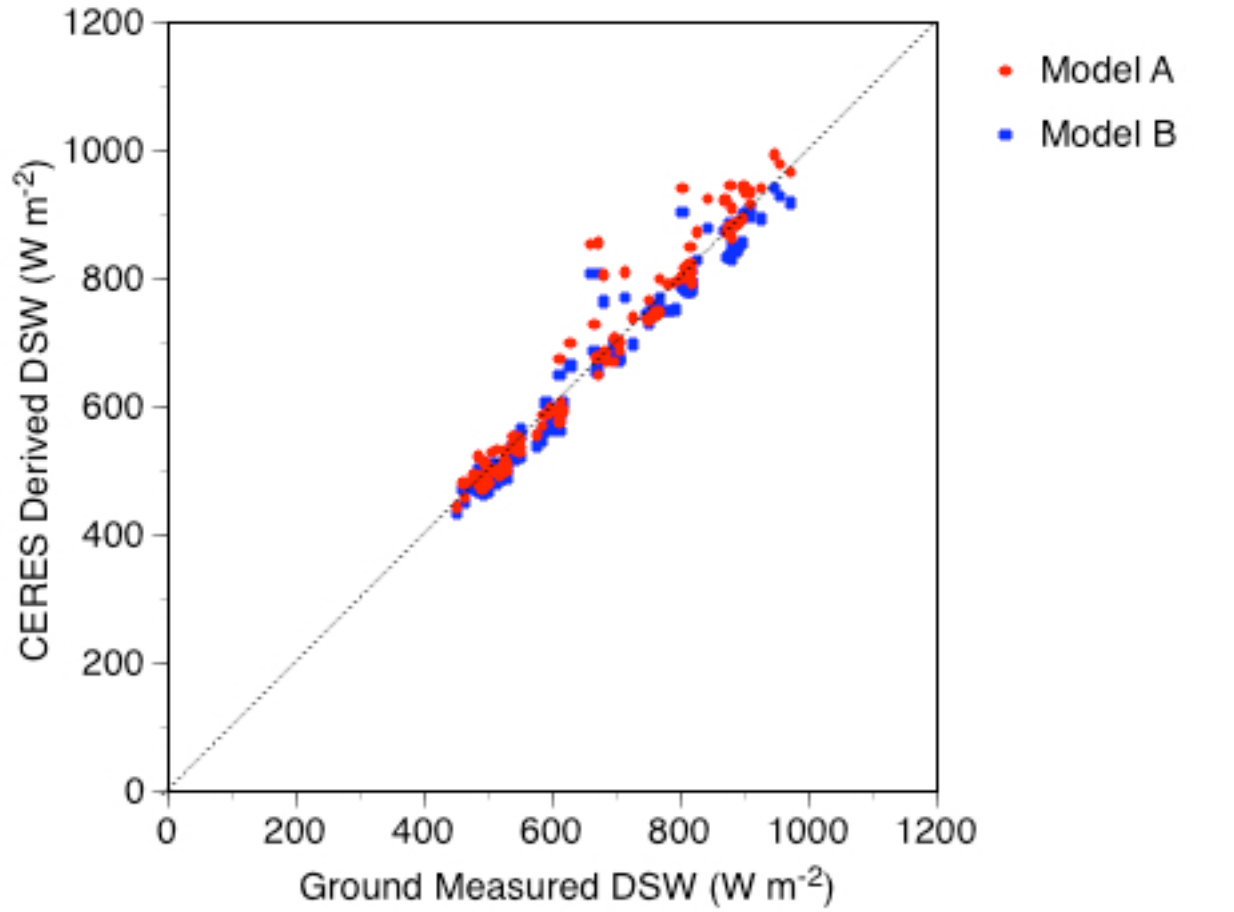
Unshaded pyranometer measurements are used when direct + diffuse measurements either are unavailable or have known problems.

Pyranometers have a nominal accuracy of ±15 Wm^{-2}, with uncertainty in the cosine response at large zenith angles (Long and Ackerman, JGR, 2000).

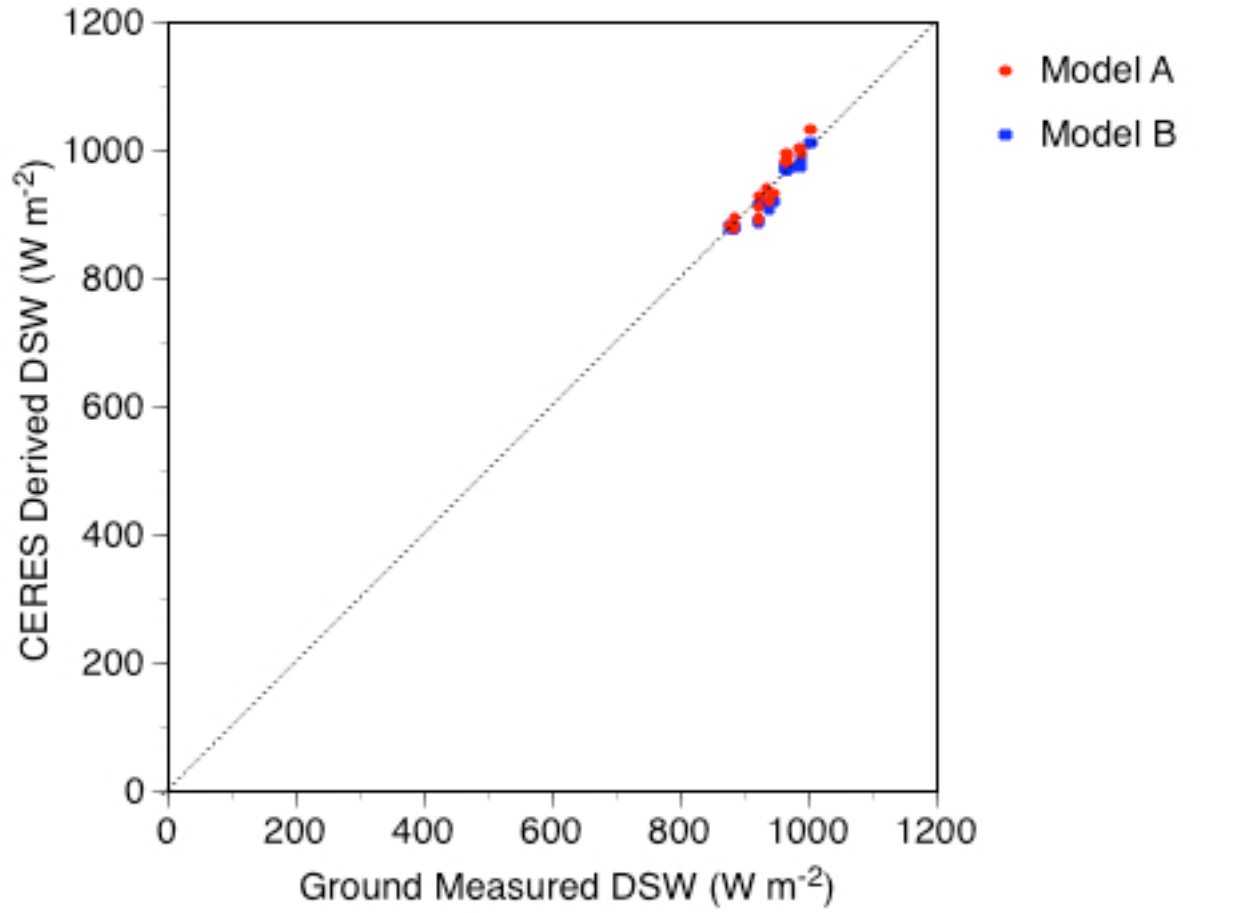
Shortwave Clear-Sky, Continental



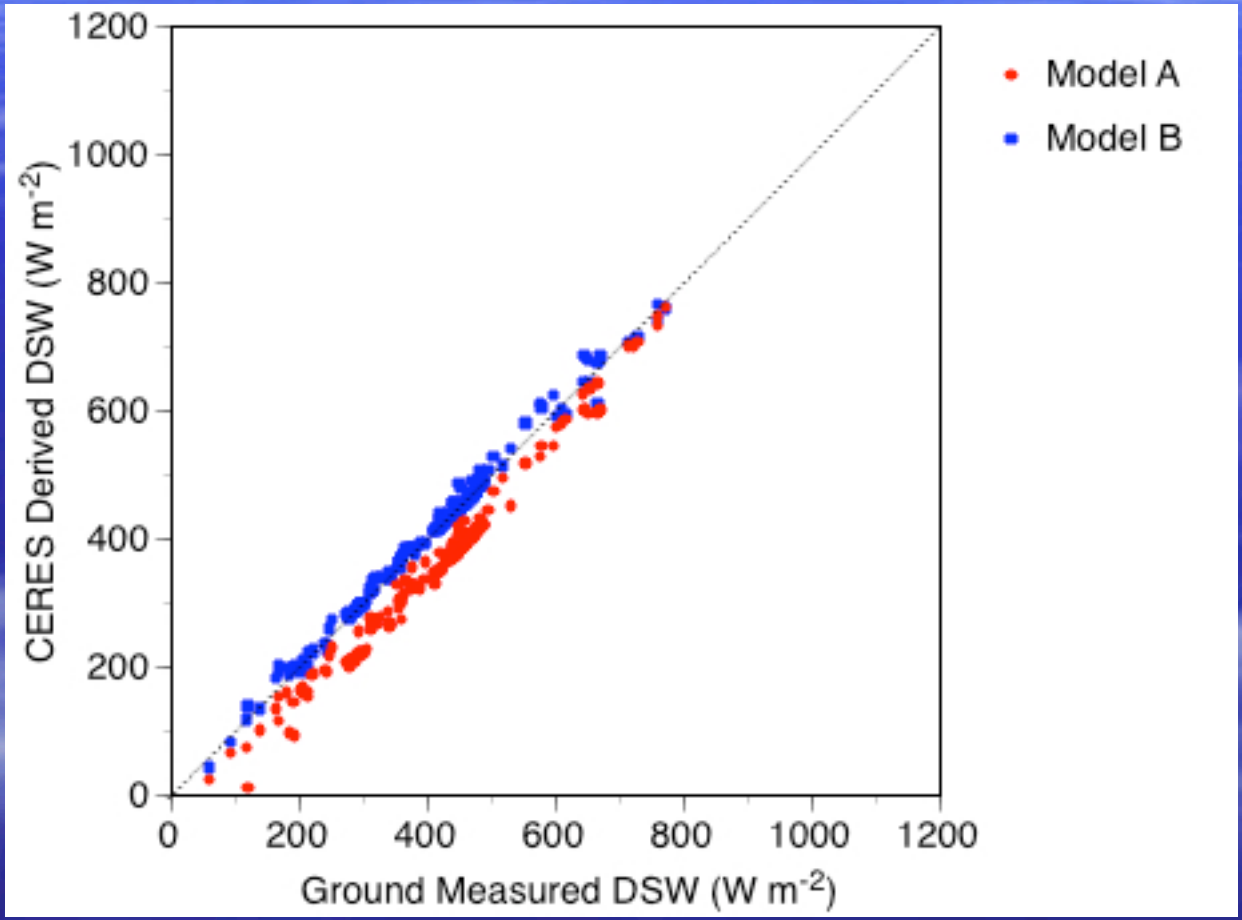
Shortwave Clear-Sky, Coastal



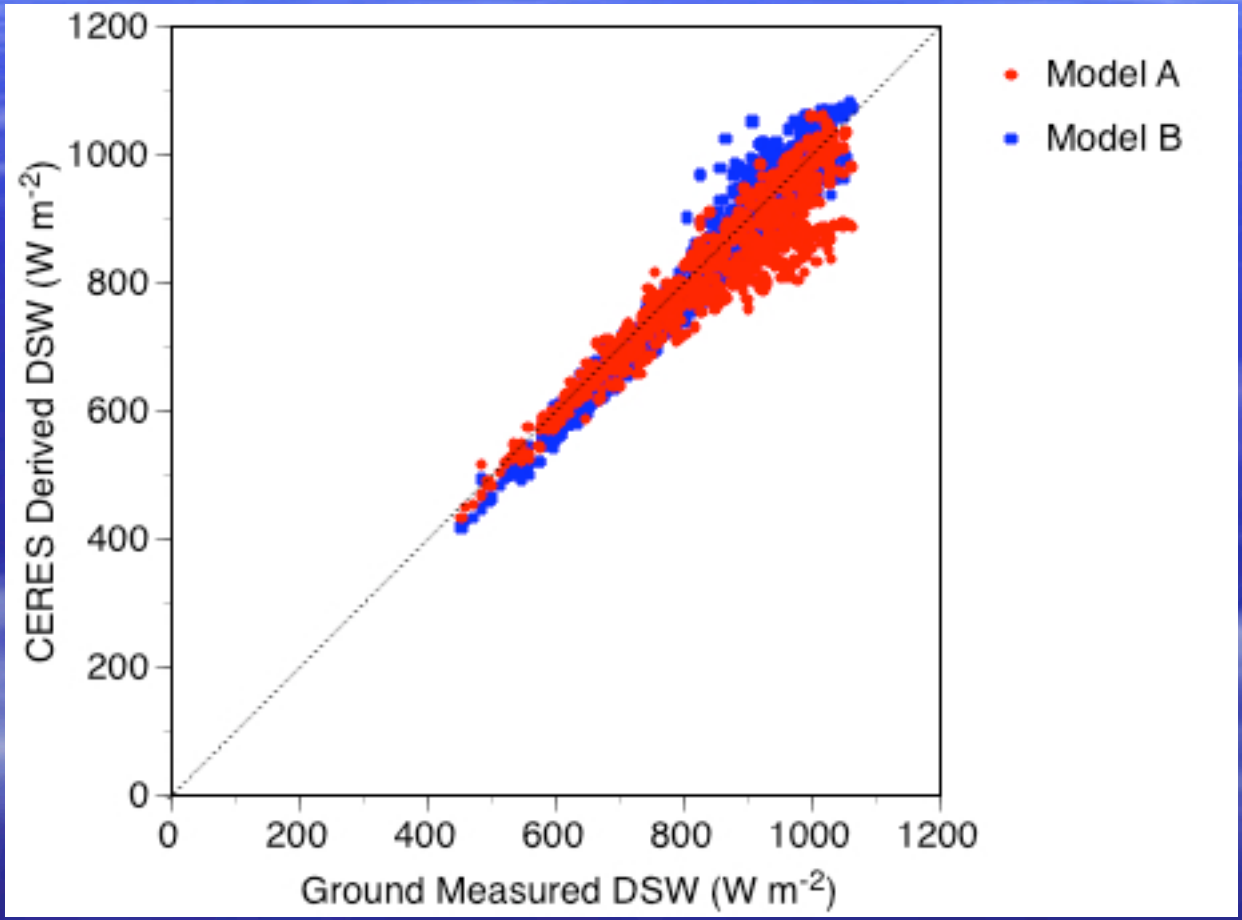
Shortwave Clear-Sky, Island



Shortwave Clear-Sky, Arctic



Shortwave Clear-Sky, Desert



SW Clear-Sky Comparisons

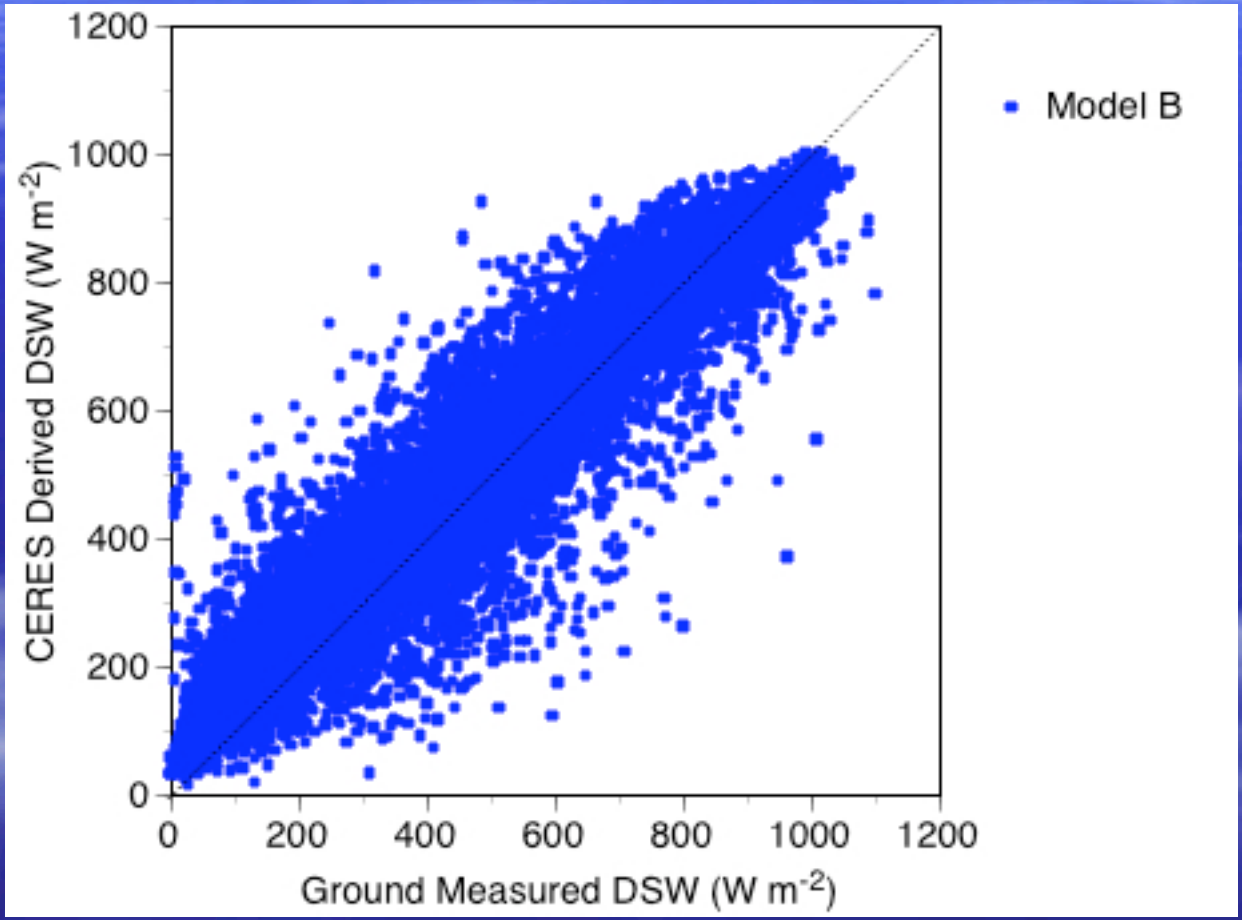
SW Model A - Terra Edition 2A

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	4409	-3.31 (-0.45)	22.8 (3.1)
Coastal	110	7.74 (1.15)	37.9 (5.6)
Island	16	4.65 (0.49)	14.0 (1.5)
(Ant)arctic	204	-58.3 (-14.1)	17.0 (4.1)
Desert	865	-36.4 (-4.3)	42.1 (5.0)

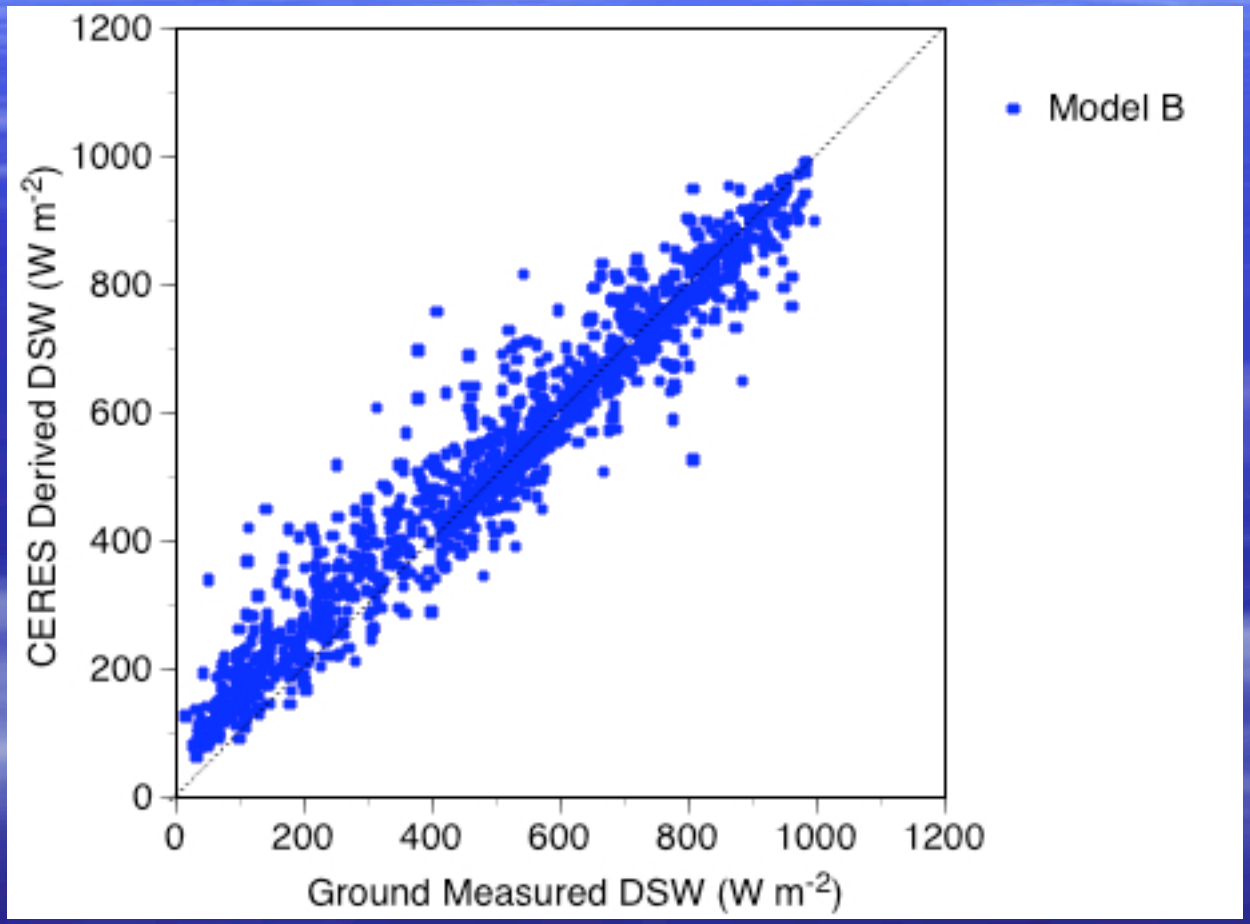
SW Model B - Terra Edition 2A

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error . Wm^{-2} (%)
Continental	4409	-21.3 (-2.9)	20.7 (2.8)
Coastal	110	-11.64 (-1.73)	31.9 (4.7)
Island	16	-9.59 (-1.01)	13.6 (1.4)
(Ant)arctic	204	1.84 (0.44)	11.1 (2.7)
Desert	865	-9.53 (-1.12)	37.5 (4.4)

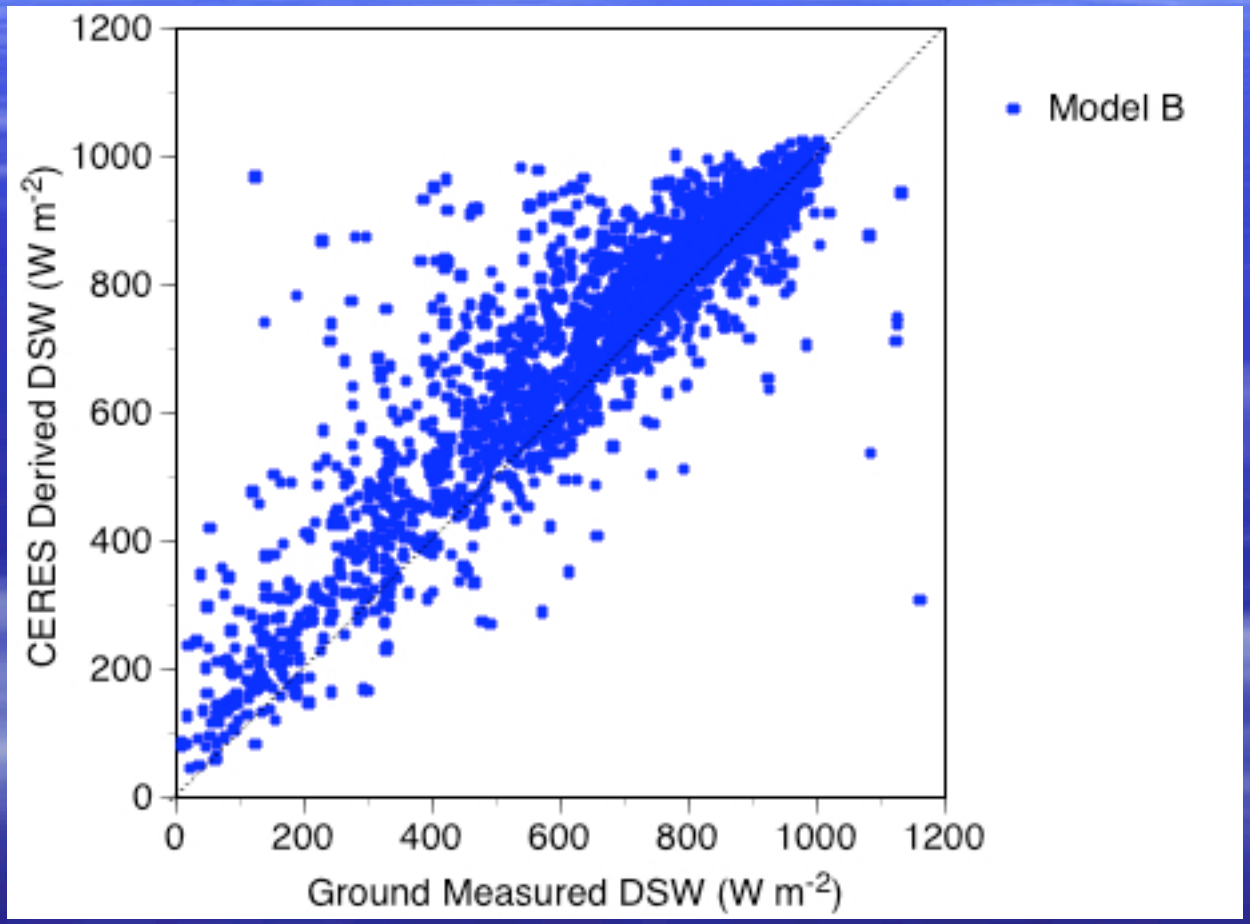
Shortwave All-Sky, Continental



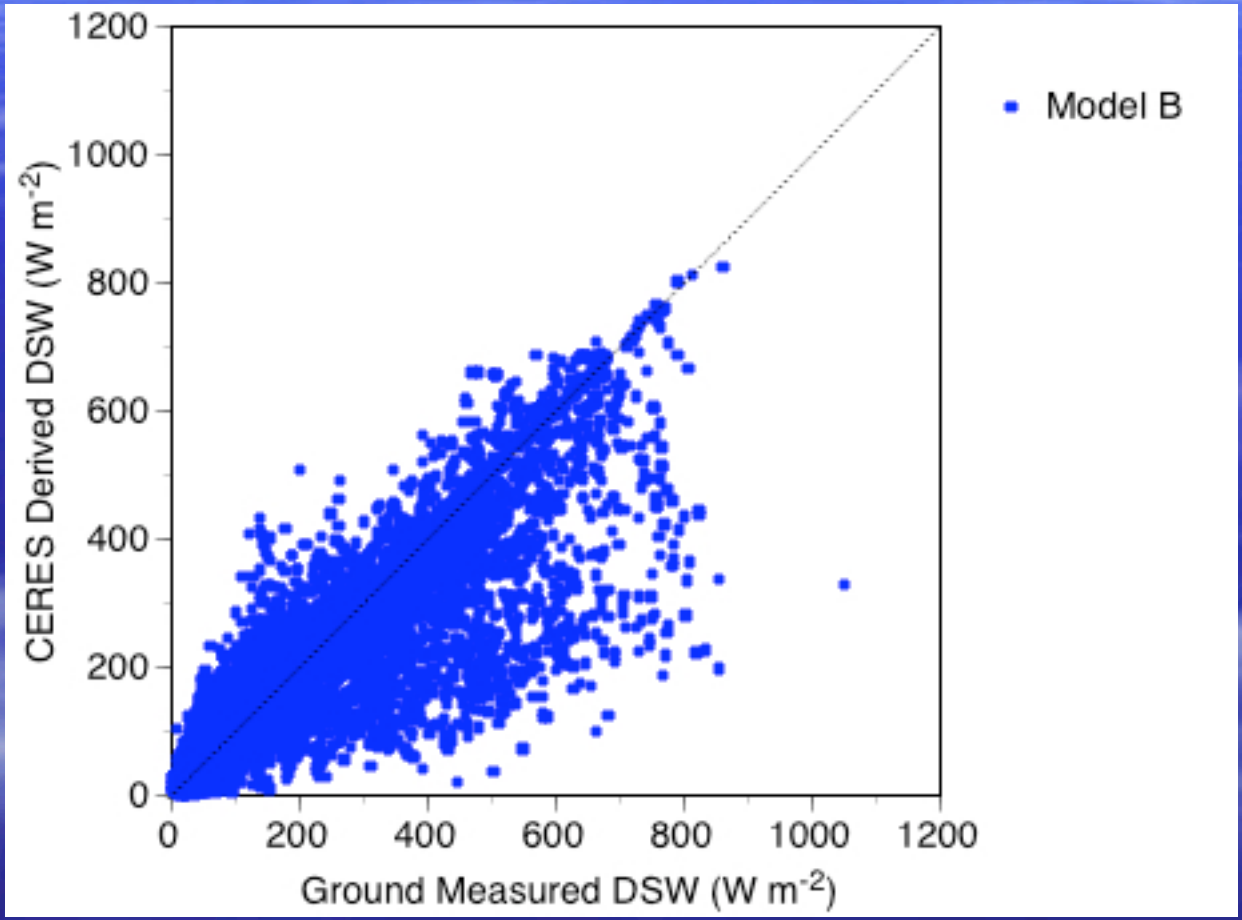
Shortwave All-Sky, Coastal



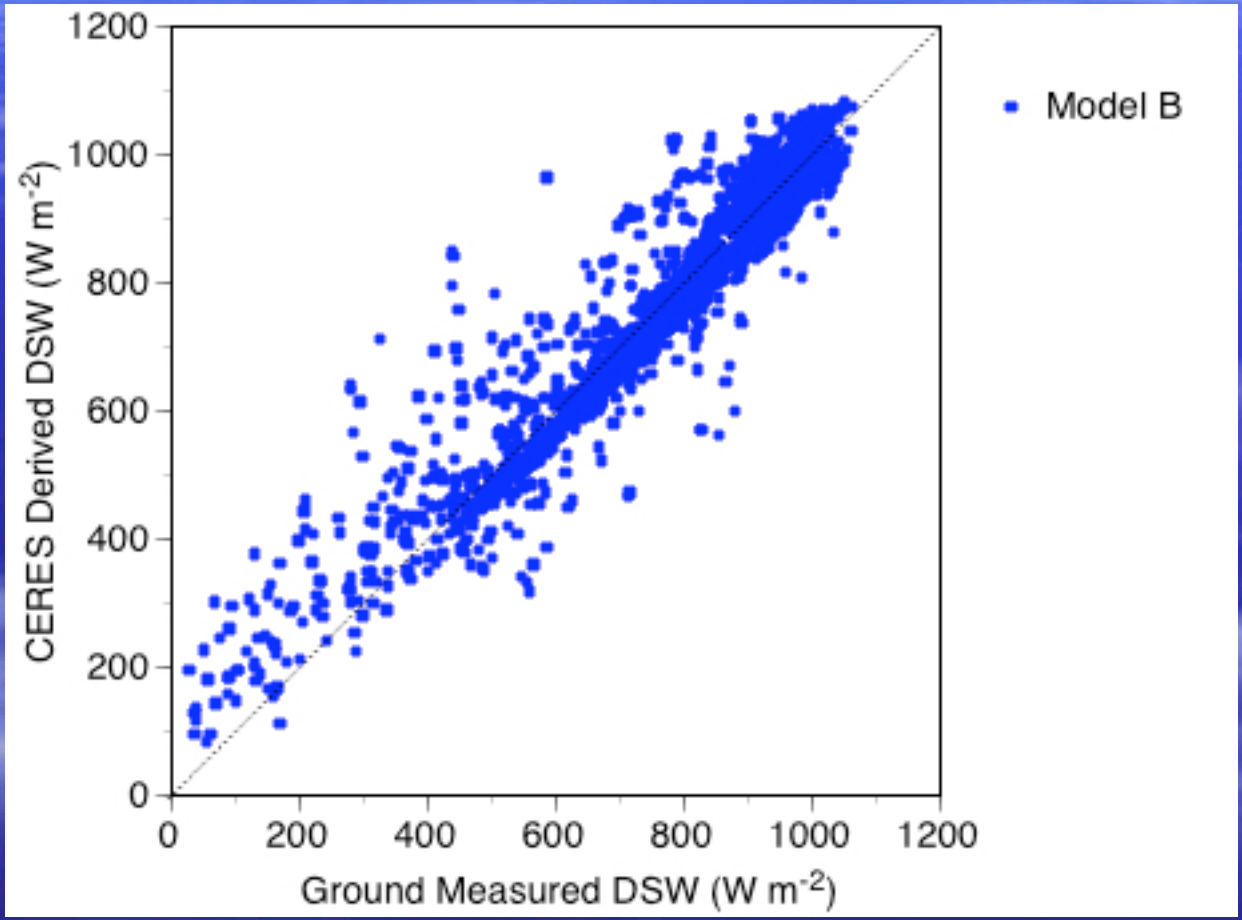
Shortwave All-Sky, Island



Shortwave All-Sky, Arctic



Shortwave All-Sky, Desert



SW All-Sky Comparisons

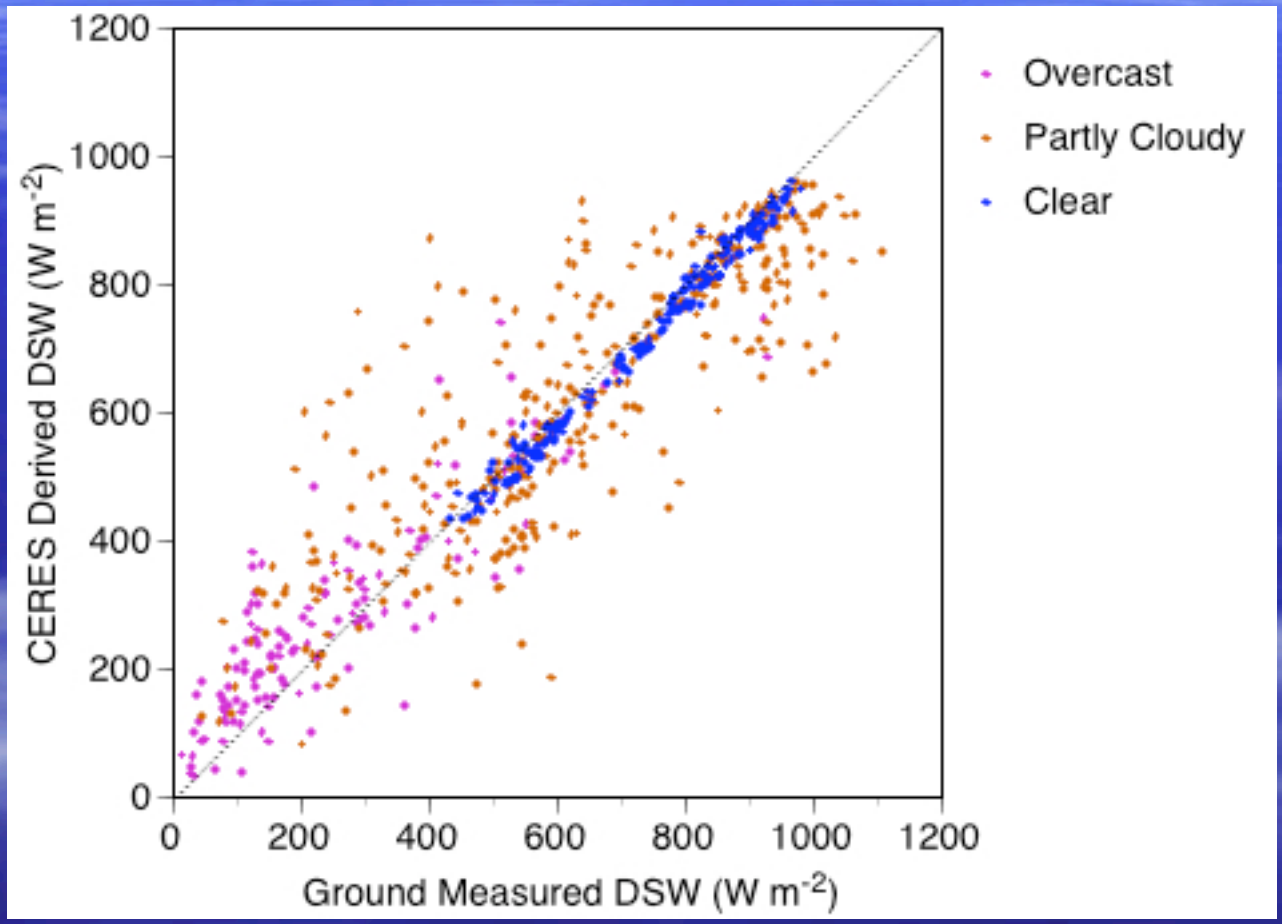
SW Model B - Terra Edition 2A (1 min)

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	16588	3.95 (0.68)	102.3 (17.7)
Coastal	1150	20.3 (4.0)	91.0 (17.8)
Island	1953	51.5 (7.7)	141.3 (21.3)
(Ant)arctic	6352	-32.1 (-12.1)	86.6 (32.6)
Desert	1764	-1.54 (-0.20)	88.6 (11.6)

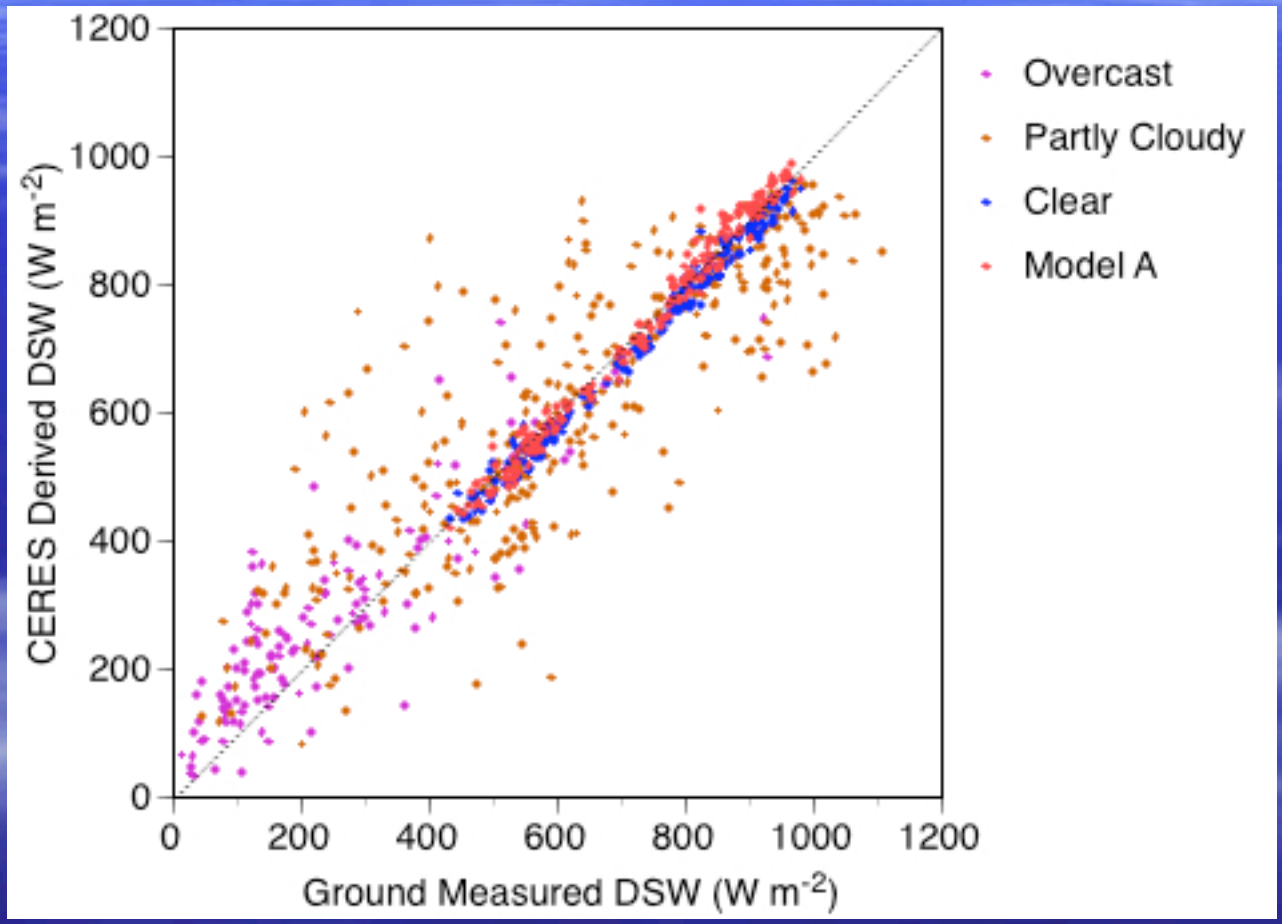
SW Model B - Terra Edition 2A (1 hr)

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error . Wm^{-2} (%)
Continental	16588	6.58 (1.14)	70.4 (12.2)
Coastal	1150	22.5 (4.4)	58.8 (11.5)
Island	1953	58.2 (8.9)	96.9 (14.7)
(Ant)arctic	6352	-32.5 (-12.2)	83.3 (31.3)
Desert	1764	2.10 (0.28)	66.9 (8.8)

SW SGP All-Sky Comparisons



SW SGP All-Sky Comparisons



SW SGP All-Sky Comparisons

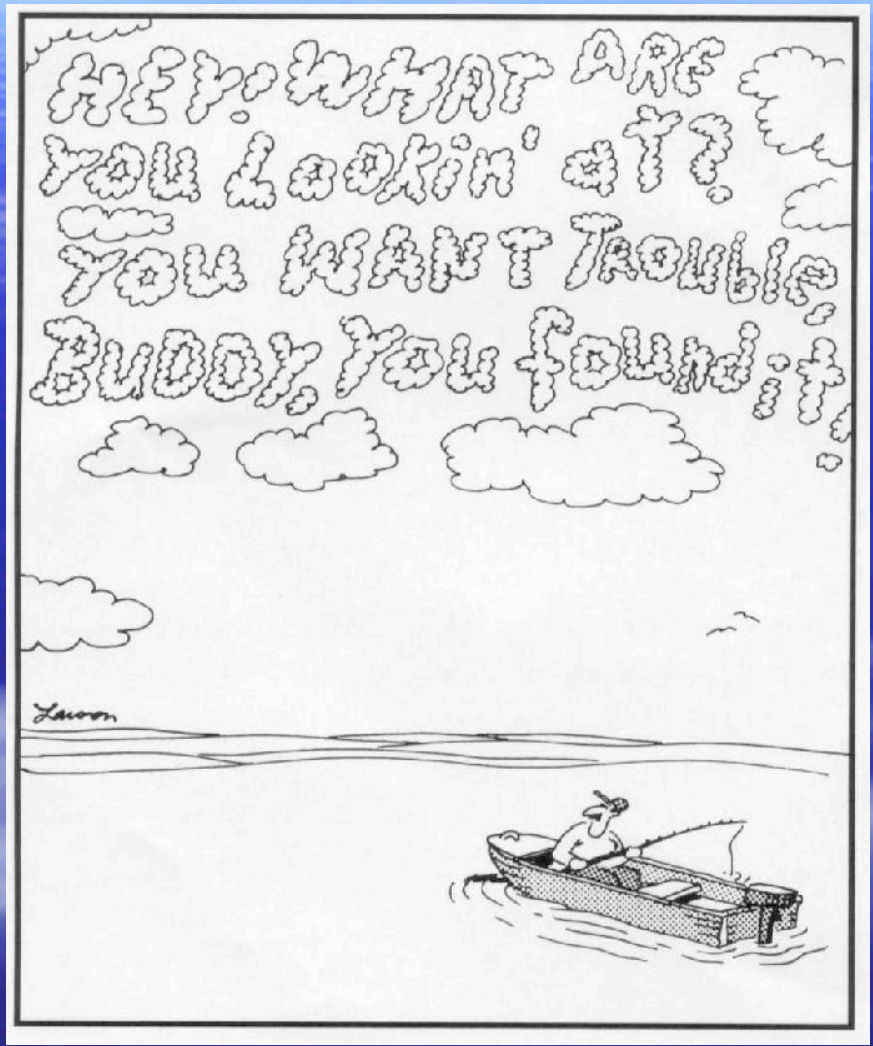
SW Model A - Terra Edition 2A

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Clear-Sky	195	-1.01 (-0.14)	20.0 (2.70)
Partly-Cloudy	0	NA	NA
Overcast	0	NA	NA
All-Sky	0	NA	NA

SW Model B - Terra Edition 2A

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error . Wm^{-2} (%)
Clear-Sky	195	-21.17 (-2.86)	17.4 (2.35)
Partly-Cloudy	366	-9.05 (-1.41)	114.3 (17.8)
Overcast	133	33.54 (13.3)	77.8 (30.8)
All-Sky	694	-4.67 (-0.78)	93.8 (15.7)

Friendly Skies?



Dave was beginning to truly appreciate that cloud fields could be a source of considerable trouble.

Conclusions: Shortwave

For clear-sky cases, CERES derived SW surface fluxes are within desired accuracies (biases) in all cases for model B, but only for continental, coastal, and island cases for model A, not for the (ant)arctic and desert cases. The source of problem appears to be the current aerosol maps, which will be replaced with a MODIS-derived climatological aerosol map.

All-sky cases are within desired accuracy limits for only the continental and desert cases for model B, not for the coastal, island, and (ant)arctic cases. Some improvement in cloud detection may be warranted.

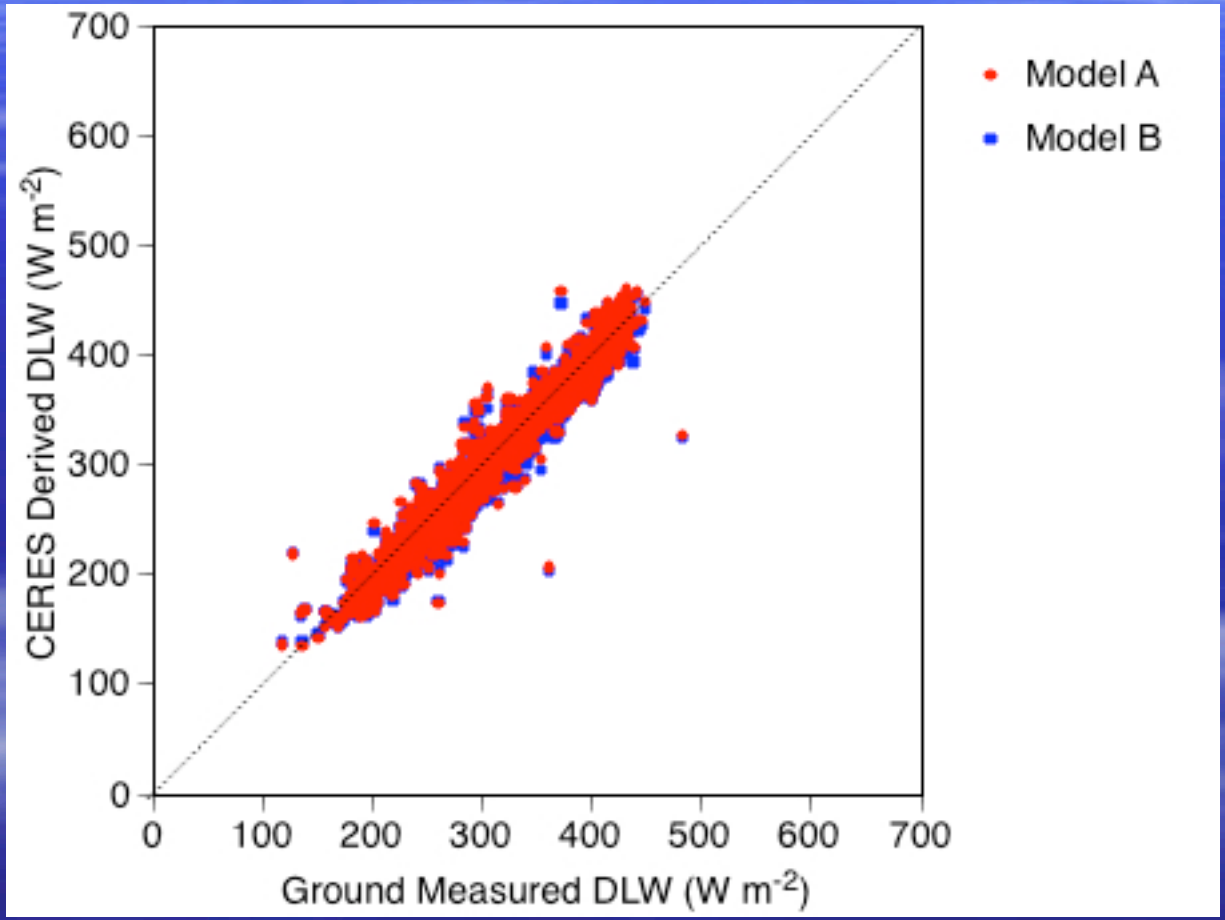
Precision still requires substantial improvement, especially for cases involving clouds.

LW Pyrgeometers Measurements

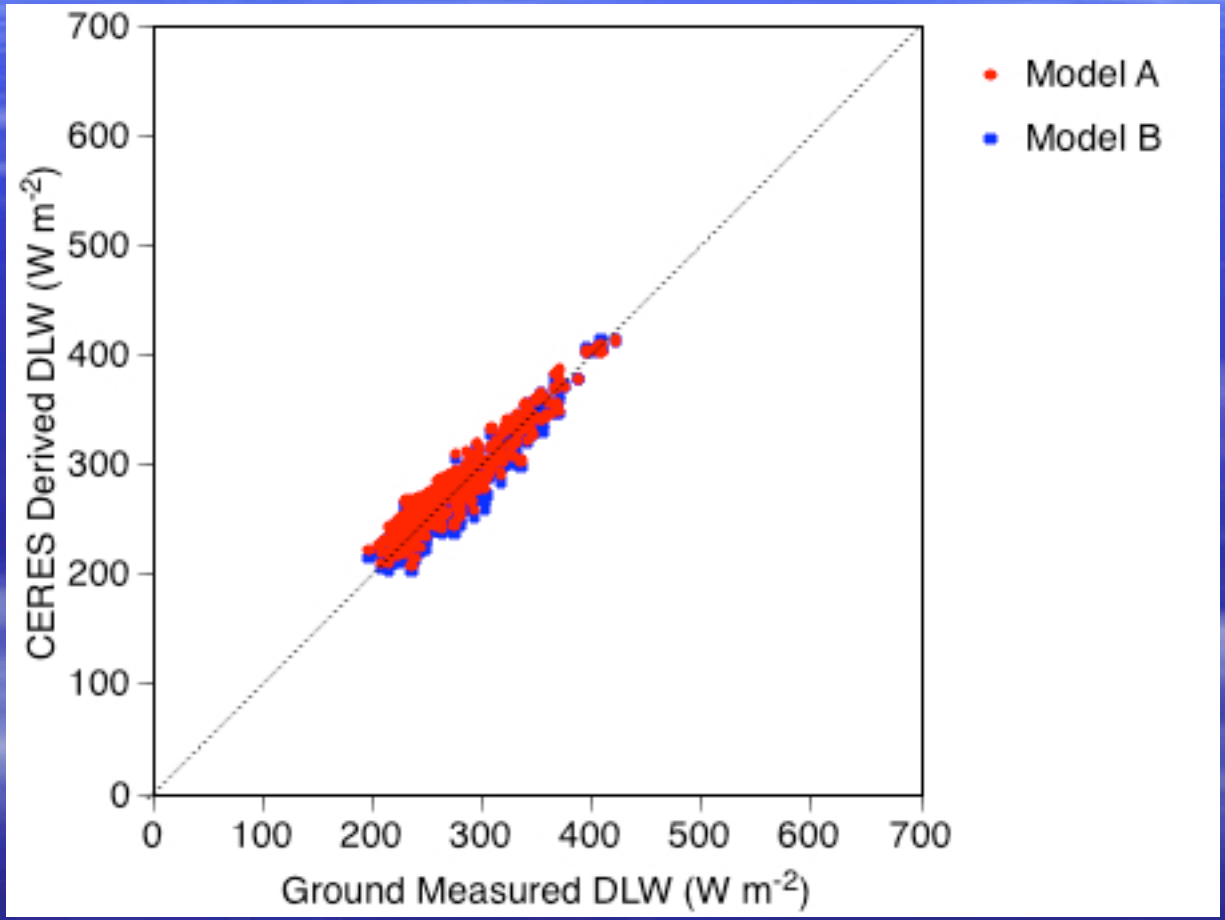
Pyrgeometer measurements have a nominal accuracy of about ±10 Wm^{-2}, although modified PIR pyrgeometers have been shown to achieve accuracies as high as ±2 Wm^{-2} (Philipona, Fröhlich, and Betz, Applied Optics, 1995).

The SOFA effort has not encountered any outstanding problems with the pyrgeometer measurements.

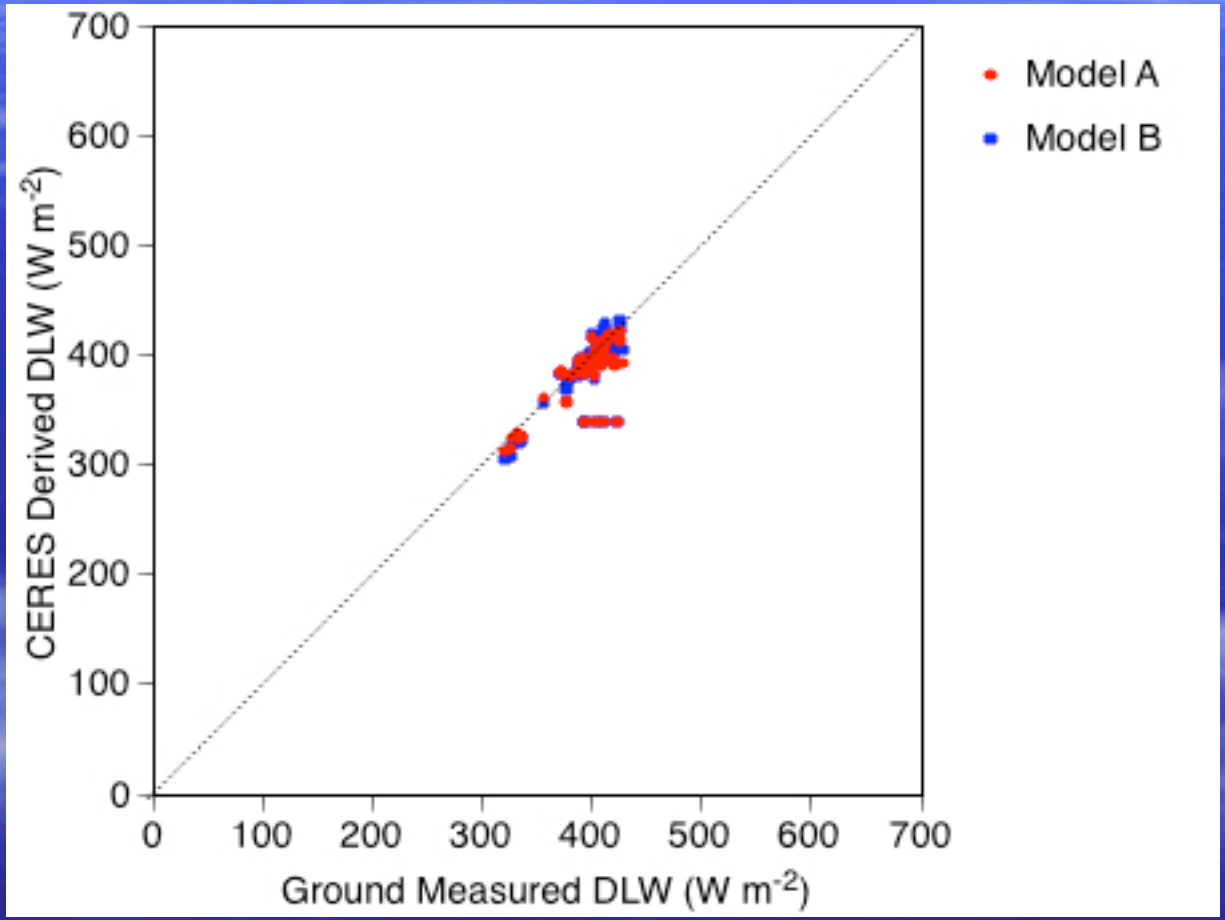
Longwave Clear-Sky, Continental



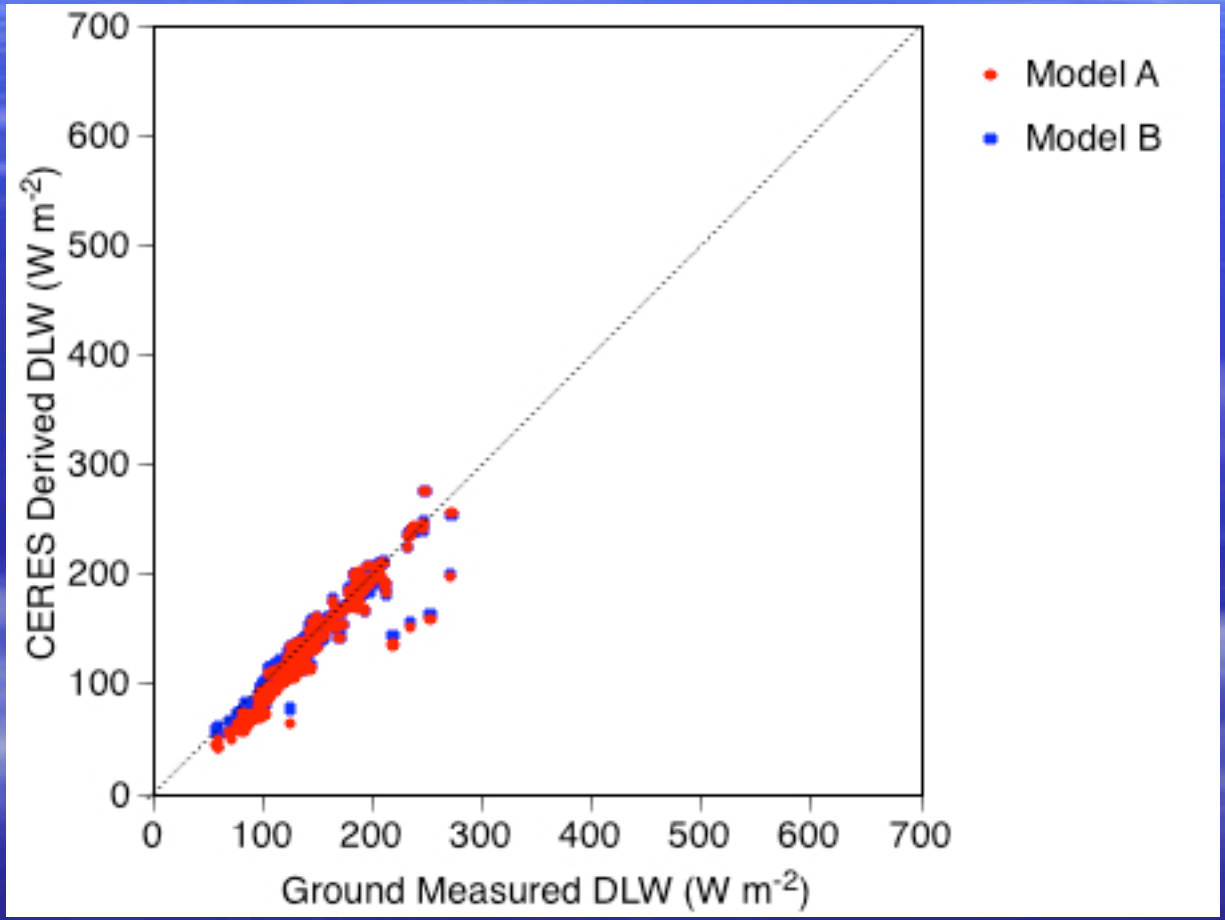
Longwave Clear-Sky, Coastal



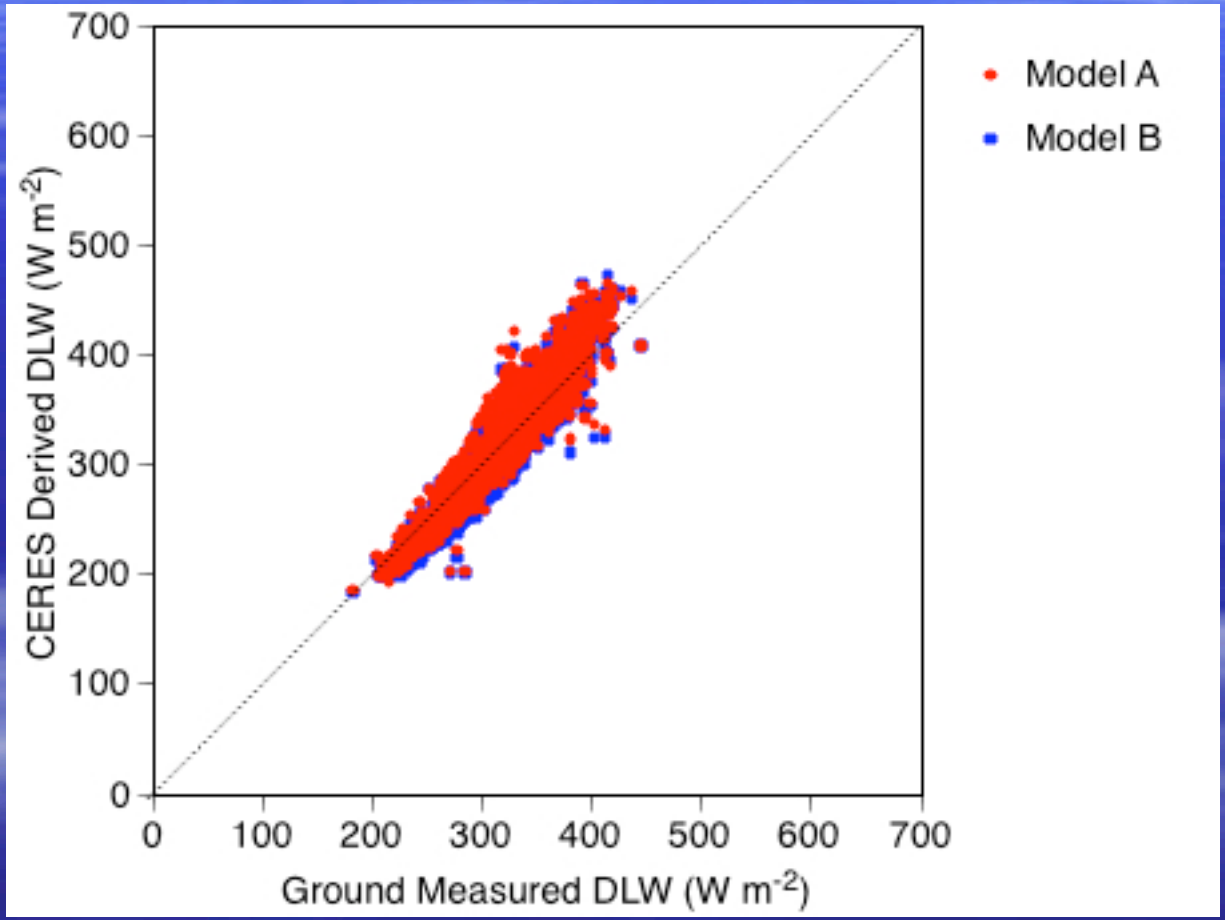
Longwave Clear-Sky, Island



Longwave Clear-Sky, Arctic



Longwave Clear-Sky, Desert



LW Clear-Sky Comparisons

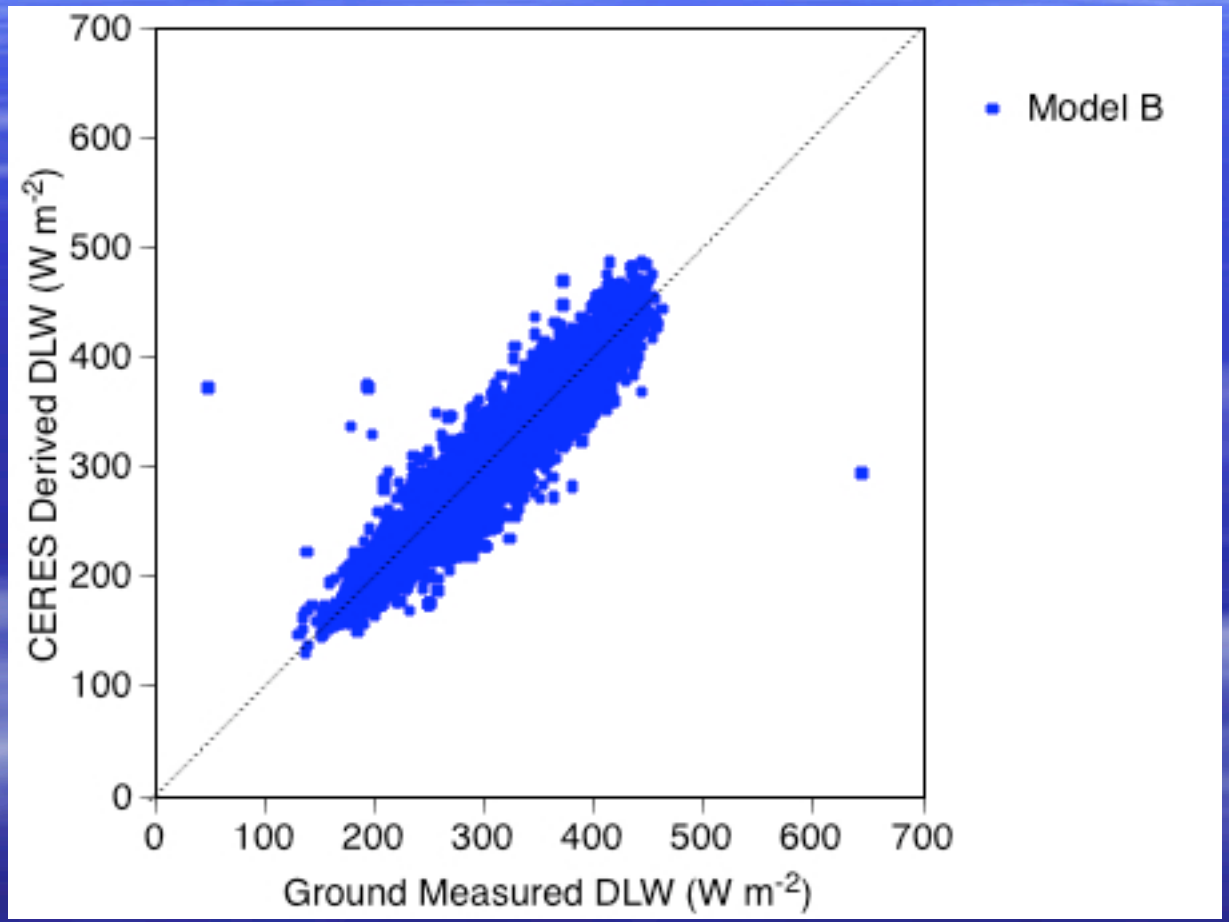
LW Model A - Terra Edition 2A

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	8960	-3.90 (-1.32)	13.7 (4.6)
Coastal	383	4.36 (1.58)	12.4 (4.5)
Island	58	-9.53 (-2.43)	19.3 (4.9)
(Ant)arctic	361	-10.30 (-7.57)	11.5 (8.4)
Desert	1668	3.66 (1.14)	19.8 (6.2)

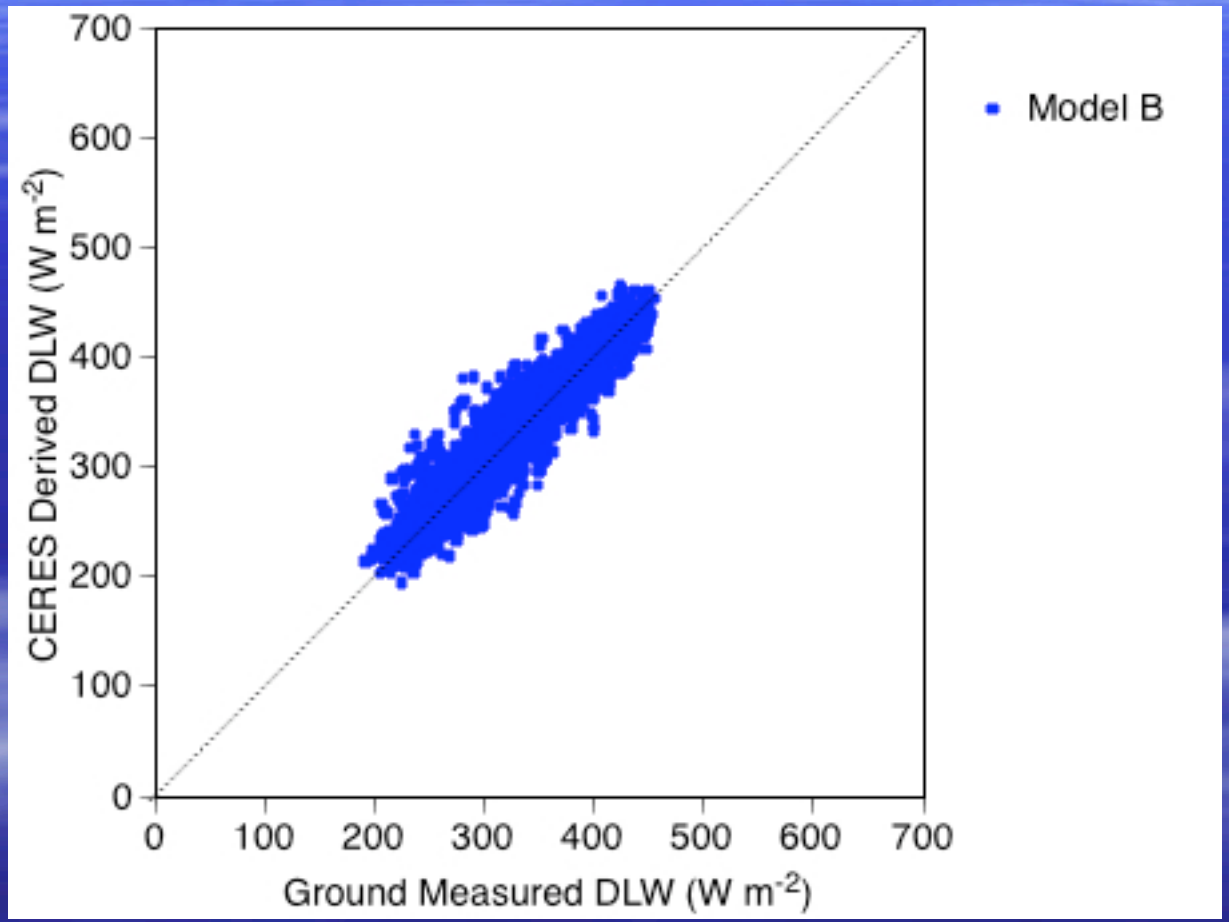
LW Model B - Terra Edition 2A

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error . Wm^{-2} (%)
Continental	8960	-7.16 (-2.42)	13.6 (4.6)
Coastal	383	-2.42 (-0.88)	12.8 (4.7)
Island	58	-7.86 (-2.00)	20.4 (5.2)
(Ant)arctic	361	-6.85 (-5.03)	10.9 (8.0)
Desert	1668	-0.99 (-0.31)	18.6 (5.8)

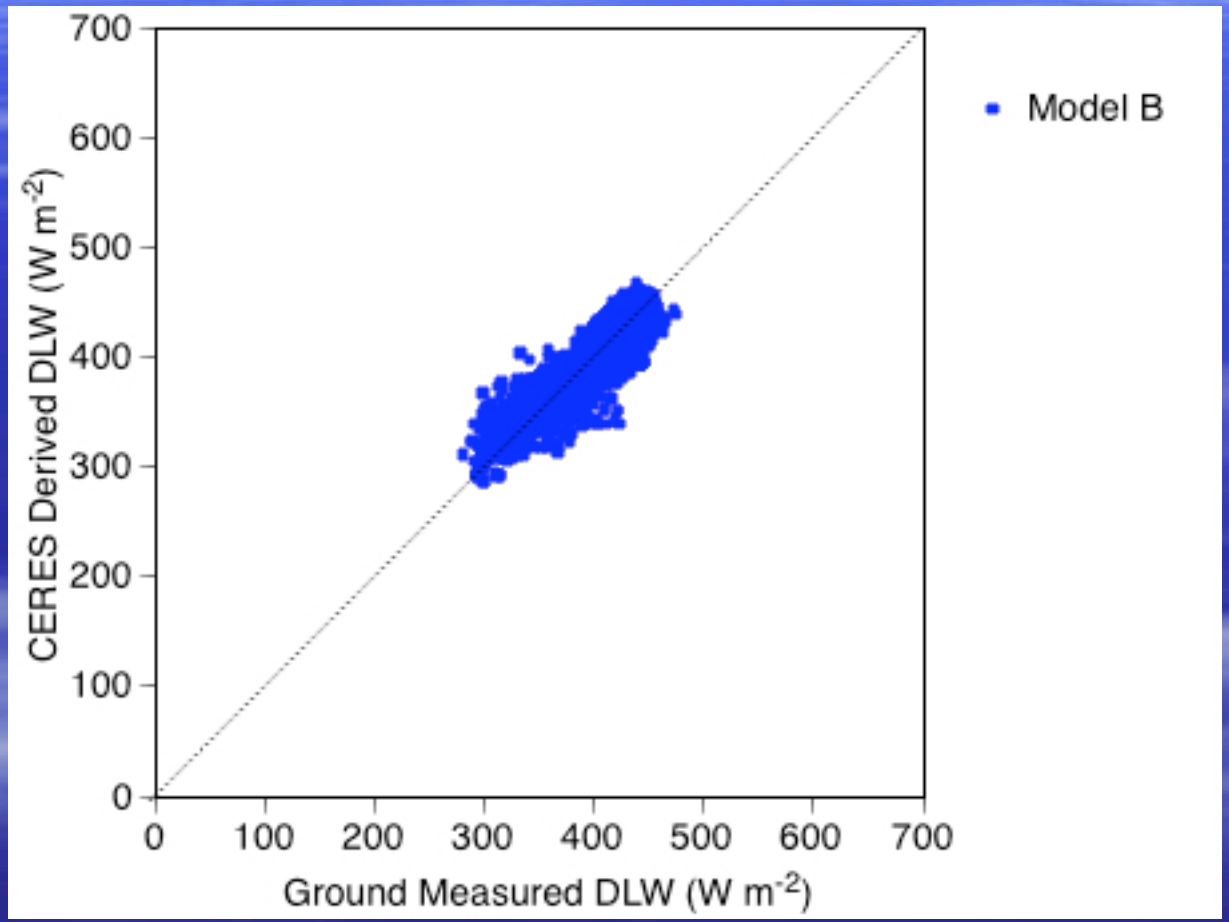
Longwave All-Sky, Continental



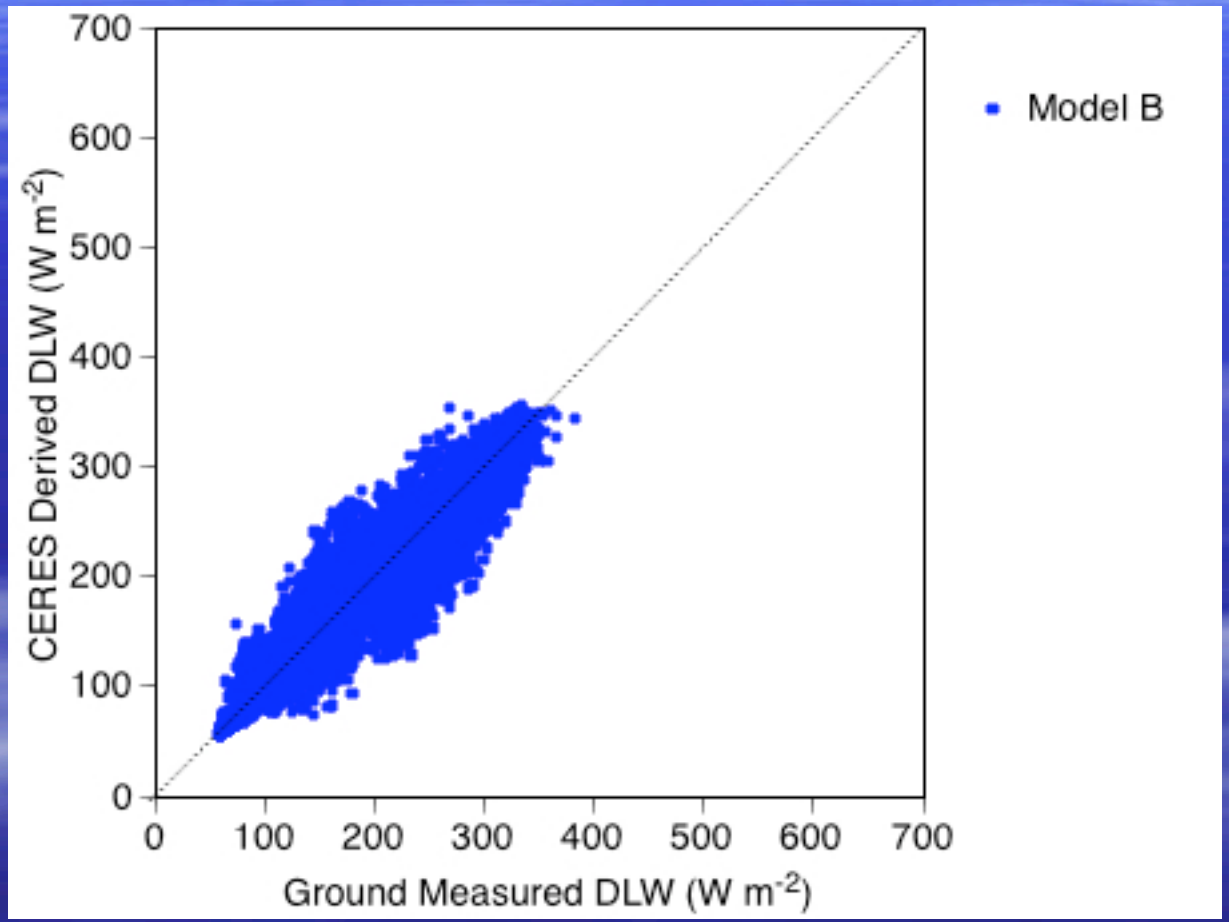
Longwave All-Sky, Coastal



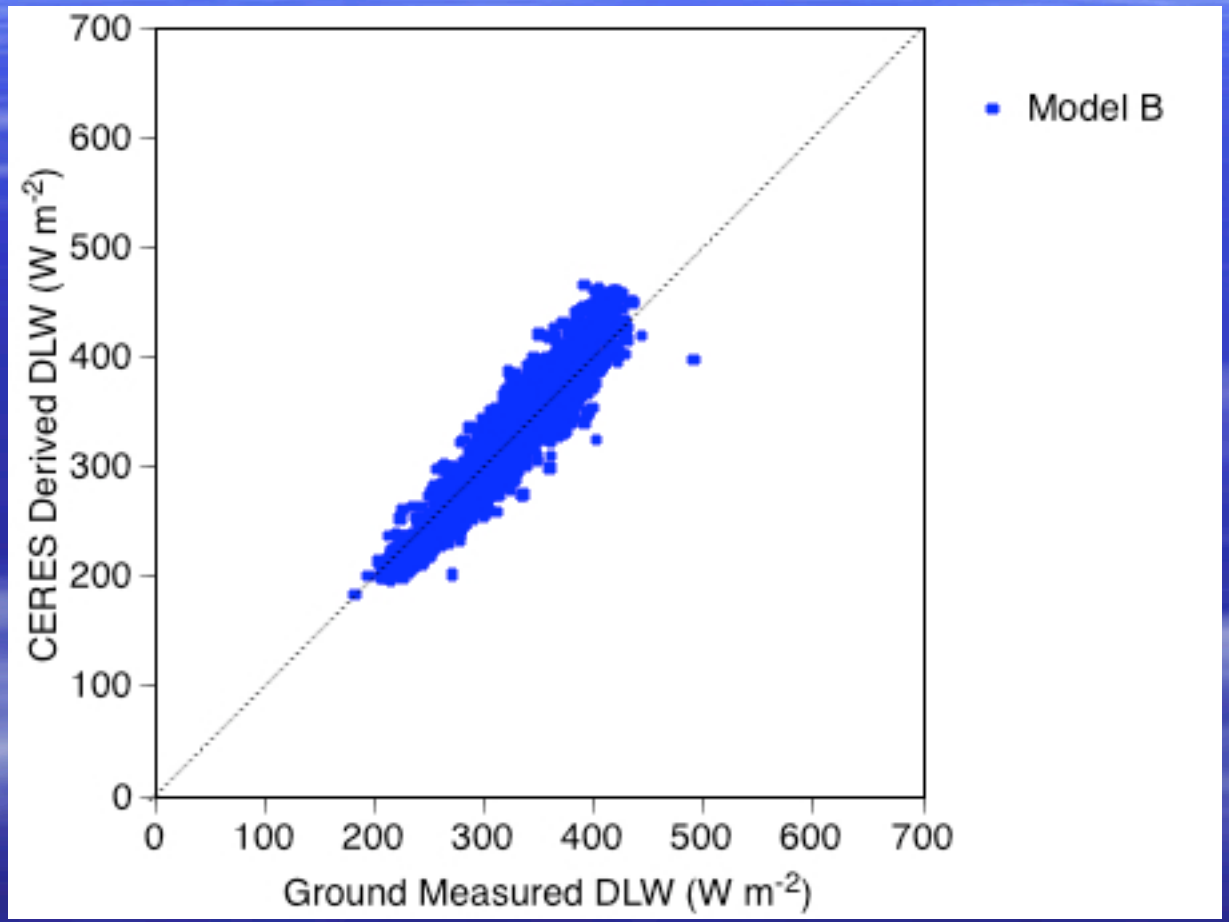
Longwave All-Sky, Island



Longwave All-Sky, Arctic



Longwave All-Sky, Desert



LW All-Sky Comparisons

LW Model B - Terra Edition 2A

Sites	# Points	Mean Bias Wm^{-2} (%)	Random Error Wm^{-2} (%)
Continental	34831	-3.04 (-0.95)	19.5 (6.1)
Coastal	2701	3.50 (1.06)	19.9 (6.0)
Island	4196	1.19 (0.29)	14.3 (3.5)
(Ant)arctic	14082	-4.24 (-2.02)	25.9 (12.3)
Desert	4028	1.49 (0.46)	19.5 (6.0)

Conclusions: Longwave

CERES derived LW surface fluxes are within desired accuracies (biases) for both clear-sky (models A & B) & all-sky (model B) cases.

Precision is also within desired limits, with the exception of all-sky (ant)arctic cases where some improvement in cloud detection may be warranted.